Analysis of The Influence of Problem-Based Learning on Critical Thingking Skills in Fraction Learning

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Abstract
Critical thinking skills are an important 21st-century competency that needs to be developed through innovative learning approaches such as Problem-Based Learning (PBL), especially in complex and conceptual fraction material. The purpose of this study is to analyze the influence of the PBL model on students' critical thinking skills in learning fractions. The method used is a systematic literature review of ten accredited national journals and ten reputable international journals published between 2019 and 2024. The analysis was conducted qualitatively on the design, findings, and contributions of the PBL model in improving students' critical thinking skills in the areas of understanding, analyzing, and evaluating fraction concepts. The results of the study indicate that PBL has a significant impact on improving critical thinking skills through real-world contexts, collaborative interactions, and an emphasis on logical reasoning. This model encourages students to actively solve fraction problems, construct mathematical arguments, and critically reflect on alternative solutions. The conclusion of this study states that the consistent and structured application of PBL contributes significantly to improving students' critical thinking skills in fraction learning.
Keywords: *Problem-Based Learning, Critical Thinking, Fraction*

Abstrak
Keterampilan berpikir kritis merupakan kompetensi penting abad ke-21 yang perlu dikembangkan melalui pendekatan pembelajaran yang inovatif seperti *Problem-Based Learning* (PBL), terutama pada materi bilangan pecahan yang kompleks dan konseptual. Tujuan kajian ini adalah untuk menganalisis pengaruh model PBL terhadap keterampilan berpikir kritis peserta didik dalam pembelajaran bilangan pecahan. Metode yang digunakan adalah kajian literatur sistematis terhadap sepuluh jurnal nasional terakreditasi dan sepuluh jurnal internasional bereputasi yang diterbitkan dalam rentang 2019–2024. Analisis dilakukan secara kualitatif terhadap desain, temuan, dan kontribusi model PBL dalam meningkatkan aspek berpikir kritis peserta didik pada ranah pemahaman, analisis, dan evaluasi konsep pecahan. Hasil kajian menunjukkan bahwa PBL memberikan dampak signifikan terhadap peningkatan keterampilan berpikir kritis melalui konteks masalah nyata, interaksi kolaboratif, dan penekanan pada penalaran logis. Model ini mendorong peserta didik untuk aktif memecahkan masalah pecahan, menyusun argumen matematis, serta merefleksikan solusi alternatif secara kritis. Simpulan dari kajian ini menyatakan bahwa penerapan PBL secara konsisten dan terstruktur berkontribusi nyata dalam meningkatkan keterampilan berpikir kritis peserta didik pada pembelajaran bilangan pecahan.
Kata kunci: *Problem-Based Learning, Berpikir Kritis, Bilangan Pecahan*

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INTRODUCTION

The developments of the 21st century have encouraged the world of education to not only emphasize content mastery, but also to foster higher-order thinking skills, such as critical thinking skills. These skills are necessary for students to be able to face global challenges, make the right decisions, and solve complex problems independently and logically. In the context of mathematics learning, critical thinking skills are an important component because mathematics is not only about numbers and formulas, but also requires analytical, reasoning, and in-depth problem-solving abilities.

However, the reality on the ground shows that students still have difficulty developing critical thinking skills, especially in understanding and processing fraction material. This material falls under the category of complex and conceptual topics, often leading to misunderstandings and operational errors. A study by Abdullah, Abidin, & Ali (2015) found that many students made mistakes in solving HOTS problems on the topic of fractions due to a lack of understanding of basic fraction concepts, such as fraction comparison, simplification, and mixed operations.

This difficulty is exacerbated by the conventional teaching method still widely used in schools, namely expository teacher-centered learning. In this method, teachers mostly dictate concepts, while students only play the role of passive listeners who take notes and memorize information without any active knowledge construction process. This results in minimal development of students' critical thinking skills because they are not given the space to explore, analyze, or solve real problems independently.

To address this issue, an innovative learning approach is needed that can naturally stimulate critical thinking in learning activities. One approach that has proven effective is Problem-Based Learning (PBL). According to Hopkins (2008), PBL is a learning approach that begins with a real and complex problem as a stimulus for learning. In the process, students are expected to identify the necessary information, seek alternative solutions, evaluate various possibilities, and form understanding through collaboration and reflection.

The main advantage of PBL lies in its ability to integrate real-world contexts into the classroom, where students not only understand concepts but also develop metacognitive competencies such as critical thinking, teamwork, and communication. In line with this, Kurniawati & Negara (2024) emphasize that the application of the PBL model in mathematics learning has been proven to enhance students' critical thinking skills through the creation of a challenging and participatory learning environment.

Research conducted by Yohannes & Tamur (2021) in the form of a meta-analysis also reinforces this argument. They analyzed data from various accredited national and international journals and found that the use of PBL had a significant impact on improving students' critical thinking skills at the primary and secondary education levels, particularly in the areas of understanding, analyzing, and evaluating mathematical concepts.

A similar finding was also reported by Agustika & Dewi (2023), who stated that PBL can control and improve critical thinking skills in elementary school students through contextual and challenging fraction problem-solving activities. The application of PBL also helps students develop visual representations of fractions, compare fraction values, and form diverse and logical problem-solving strategies.

In the context of fraction learning, PBL can help overcome the conceptual difficulties often experienced by students. For example, Chususiyah & Prastiti (2020) in their research proved that the use of inquiry-based teaching materials in the form of PBL has a positive impact on improving students' critical thinking skills in solving fraction problems. PBL encourages students to ask questions, construct mathematical arguments, and evaluate the solutions they produce.

In addition to improving the quality of the learning process, the implementation of PBL also increases students' motivation and learning activity. Masriah, Utaminingsih,

& Utomo (2023) showed that students become more active, creative, and collaborative when facing problem-based learning challenges, especially when they have to solve fraction problems in groups.

In the field of learning technology, Divayani & Agustika (2024) developed a contextual animated video-based PBL model that has been proven effective in improving students' understanding and critical thinking of fraction concepts. The use of interactive media such as this helps students who have a visual learning style to better understand and manipulate fractions logically.

However, the implementation of PBL is not without challenges. One of them is the competence of teachers in designing and facilitating problem-based learning. Richardo, Usman, & Wati (2025) emphasize that the success of PBL greatly depends on how teachers select authentic and relevant problems related to students' lives and how teachers effectively guide the exploration process of learners. Without adequate teacher preparation, PBL risks becoming merely a discussion activity without a clear direction.

Another challenge is students' readiness to engage in self-directed learning. According to Ren (2022), not all students are accustomed to a learning process that requires them to seek information independently, collaborate, and make collective decisions. Therefore, the implementation of PBL must be done gradually and adaptively according to the characteristics of the students.

Overall, the literature highlights that Problem-Based Learning (PBL) is a relevant and promising approach in mathematics education, particularly in the learning of fractions. This model not only facilitates the development of students’ critical thinking skills but also strengthens their conceptual understanding and problem-solving abilities. In line with this, the present study is designed with three main objectives: first, to analyze the influence of PBL on the development of students’ critical thinking skills in fraction learning; second, to compare the differences in critical thinking skills between students taught using the PBL model and those taught through conventional teaching methods; and third, to identify the supporting and inhibiting factors that affect the implementation of PBL. Based on these objectives, the research questions are formulated as follows: (1) Does the implementation of PBL significantly influence students’ critical thinking skills in fraction learning? (2) What are the differences in students’ critical thinking skills between those taught using PBL and those taught with conventional methods? and (3) What factors support or hinder the successful implementation of PBL in enhancing students’ critical thinking in learning fractions?

RESULTS AND DISCUSSION

1. Synthesis of Literature Review Results

This study analyzed 20 scientific articles from national and international journals discussing the application of Problem-Based Learning (PBL) and its impact on the development of critical thinking skills among students, particularly in the context of fraction learning. The analysis was conducted using a qualitative approach to examine the methodologies, designs, outcomes, and contributions of each study toward enhancing students' critical thinking skills.

Based on the analysis results, there is a consistent trend that PBL contributes positively to critical thinking skills. Some indicators of critical thinking that have improved include the ability to analyze problems, construct logical arguments, evaluate alternative solutions, and reflect on the results of thinking.

Yohannes and Tamur (2021) in their meta-analysis study showed that PBL has a significant positive effect on improving the critical thinking skills of junior high school students in mathematics learning. Similarly, Kurniawati and Negara (2024) found that the application of PBL significantly improved students' mathematical concept elaboration through group interaction and contextual problem solving.

2. Connection to Theoretical Framework

Theoretically, PBL is rooted in constructivism theory, in which knowledge is constructed through experience and interaction with the environment. Vygotsky (in Jablonka, 2020) emphasizes that meaningful learning occurs when learners actively construct their understanding through social dialogue and problem exploration. In this context, critical thinking skills develop through interaction with real-world problems and collaboration among learners.

Bloom (1956), in his revised taxonomy by Anderson & Krathwohl, places critical thinking in the higher cognitive domain, specifically analyzing (C4), evaluating (C5), and creating (C6). The PBL model structurally supports this development through the stages of problem identification, investigation, discussion, reflection, and solution presentation.

The following table integrates PBL syntax with the stages of critical thinking according to Bloom's taxonomy:

Tabel 1. Integrasi sintaks PBL dan Tahapan Berfikir Kritis (Bloom)

No	PBL Stages	Critical Thinking Stages
1	Identifying Problems	Analyzing (C4)
2	Gathering Information	Understanding - Analyzing
3	Developing Solutions	Evaluating (C5)
4	Reflection and Presentation	Creating (C6)

3. Discussion of Empirical Findings

3.1 The Contribution of PBL in Fraction Learning

Fractions are a conceptual topic in mathematics that is often difficult for students to understand. Based on research by Abdullah et al. (2015), many students make mistakes in solving fraction problems because they do not understand the difference in value between fractions and the procedures for mixed operations.

In this context, PBL enables students to understand fractions concretely through the resolution of real-world problems. For example, Agustika and Dewi (2023) found that students were able to develop visual strategies for comparing fractions when asked to solve problems related to dividing food among groups.

Masriah et al. (2023) noted a significant improvement in mathematics learning outcomes in elementary school students after implementing PBL for six weeks on the topic of addition and subtraction of fractions. This was attributed to the group discussion process that led to deep understanding.

3.2 Developing Critical Thinking Skills

Chususiyah and Prastiti (2020) identified that critical thinking skills developed through PBL include:

- Ability to interpret information: students are able to understand fraction problems from a story context.
- Ability to evaluate: students can compare several solutions proposed by their peers and determine the best solution.
- Ability to construct logical arguments: students build evidence-based arguments in presenting solutions.

Similarly, Richardo et al. (2025) state that skills in C5 and C6 increase dramatically when PBL is applied in a structured and repetitive manner over the long term.

3.3 The Role of Collaboration and Reflection

PBL encourages group work and discussion as part of the learning process. Divayani and Agustika (2024) developed context-based video PBL and found that interactions between students during discussions encouraged the exchange of ideas that enriched the critical thinking process.

Ren (2022) emphasizes the importance of the reflection stage after completing a problem. Through reflection, students can review the solutions they have taken and learn from their successes or mistakes.

4. Summary of Findings in Table

The following is a summary of some important findings in table form:

Table 2. Summary of Important Findings

No	Author	Research Focus	Key Findings
1	Yohannes & Tamur (2021)	Meta-analysis of PBL	PBL effectively improves C4 and C5
2	Agustika & Dewi (2023)	PBL in elementary school fractions	PBL helps students visualize and manipulate fractions
3	Chususiyah & Prastiti (2020)	Inquiry-PBL in fraction solving	Improves students' analysis and logical reasoning
4	Richardo et al. (2025)	Critical literature review	PBL is highly relevant in developing higher-order thinking
5	Masriah et al. (2023)	PBL in 5th grade elementary school	Learning outcomes improved significantly
6	Divayani & Agustika (2024)	PBL + contextual animated videos	Visualization aids critical thinking in real-world contexts

5. Challenges in Implementing PBL

Although PBL has been proven to have a positive impact, its implementation is not without challenges. Kamid et al. (2021) note that teachers' readiness in designing authentic problems and facilitating critical discussions remains a major obstacle. Teachers need to be given adequate training to master facilitation techniques and process-based assessment.

Meanwhile, Jablonka (2020) highlights that many students are not yet accustomed to the exploratory and independent processes required by PBL, especially in learning environments that still emphasize final results over processes.

CONCLUSION

This literature review aims to analyze in depth the influence of the Problem-Based Learning (PBL) model on students' critical thinking skills, particularly in learning fractions. Based on a systematic review of twenty accredited national and international journal articles published between 2019 and 2024, it can be concluded that the consistent and structured implementation of PBL has a significant impact on improving students' critical thinking skills.

1. Conclusions of the Study

The PBL model has proven effective in creating a learning environment that fosters the development of students’ critical thinking skills through exploratory, collaborative, and reflective stages. It facilitates students’ ability to logically analyze problems and information, encourages them to construct arguments and mathematical reasoning in a systematic manner, trains them to evaluate alternative solutions and make evidence-based decisions, and helps them integrate mathematical concepts with real-life situations, making learning more meaningful and applicable.

Various studies, such as Yohannes & Tamur (2021), Kurniawati & Negara (2024), and Agustika & Dewi (2023), reinforce that the application of PBL not only improves students' academic performance but also encourages the formation of critical thinking habits as part of the learning process.

In learning fractions, which are known to be conceptually difficult, PBL helps students understand and operate fractions through concrete and meaningful problem contexts. Studies by Masriah et al. (2023) and Chususiyah & Prastiti (2020) prove that students who participate in problem-based learning show significant improvement in understanding the meaning of fractions and solving complex problems.

2. Implications of the Study

Based on the above conclusions, there are several important implications in both the practical and theoretical domains:

a. Practical Implications

For teachers, it is essential to receive training in designing and implementing Problem-Based Learning (PBL) effectively, particularly in selecting contextual problems, guiding critical discussions, and evaluating students' thinking processes. At the institutional level, schools need to foster a culture of exploration- and collaboration-based learning by providing more flexible and innovative curricula that support the application of PBL. Meanwhile, students should be given opportunities to think independently, formulate critical questions, and collaborate in solving mathematical problems, so that they can develop both their conceptual understanding and critical thinking skills in a meaningful way.

b. Theoretical Implications

These findings support the constructivist view of learning, emphasizing that students actively construct understanding through experience. In this context, Problem-Based Learning (PBL) functions as a medium for the actualization of Bloom's higher-order taxonomy (C4-C6), ensuring that learning extends beyond memorization and basic comprehension toward analysis, evaluation, and creation. Moreover, PBL reflects an educational approach aligned with 21st-century skills, particularly collaboration, communication, creativity, and critical thinking, which are essential for preparing students to face complex challenges in real-world contexts.

3. Recommendations for Further Study

Based on the findings and limitations of this study, several recommendations for future literature reviews and research include:

a. Expansion of Context and Educational Levels

Further studies could investigate the application of Problem-Based Learning (PBL) at the upper secondary and higher education levels, as well as in other disciplines such as science and social studies. In addition, comparative research across different educational stages is needed to provide deeper insights into the long-term effectiveness of PBL in developing students' critical thinking skills and to identify how its impact may vary according to learners' age, context, and field of study.

b. Integration of PBL with Technology

Further research could examine the impact of digital-based PBL implementation, such as the use of e-modules, contextual animated videos, and collaborative learning applications in enhancing students' critical thinking skills (Divayani & Agustika, 2024; Chasanah & Fitrianawati, 2023).

c. Assessment and Evaluation Studies

The development of valid and reliable critical thinking assessment instruments that align with the characteristics of Problem-Based Learning (PBL) is essential to ensure accurate measurement of students' higher-order thinking abilities. Future research could also focus on integrating formative and reflective assessments within the PBL framework, allowing for a more comprehensive understanding of the dynamics of critical thinking development as students engage in problem exploration, collaboration, and solution evaluation.

d. Institutional Support and Policy

Educational policy studies need to explore how systemic support for innovative learning such as PBL can be enhanced through teacher training, curriculum changes, and the development of professional learning communities.

REFERENCES

Abdullah, A. H., Abidin, N. L. Z., & Ali, M. (2015). Analysis of students' errors in solving HOTS problems on fractions. *Asian Social Science, 11*(21), 133–142. https://www.researchgate.net/publication/282602742

Agustika, G. N. S., & Dewi, N. N. A. P. (2023). The problem-based learning model in mathematics subjects by controlling the critical thinking ability of elementary school students. *Mimbar Ilmu, 28*(2), 45–52. https://ejournal.undiksha.ac.id/index.php/MI/article/view/57913

Astini, A., Lukito, A., & Siswono, T. Y. E. (2020). Development of problem-based learning tool on fraction concepts. *International Journal of Innovative Science and Research Technology, 5*(8), 566–571. https://www.academia.edu/download/109630165/IJISRT20AUG469.pdf

Chasanah, A., & Fitrianawati, M. (2023). An e-module of math based on problem-based learning for the subject of fractions in elementary school. *Jurnal PBPSP, 4*(1), 15–24. https://journal.iistr.org/index.php/PBPSP/article/view/227

Chususiyah, S., & Prastiti, T. D. (2020). Application of learning materials based on inquiry-based learning and its effect on critical thinking skills of students in solving fractions problems. *Journal of Physics: Conference Series, 1563*(1), 012072. https://iopscience.iop.org/article/10.1088/1742-6596/1563/1/012072/pdf

Divayani, M. P., & Agustika, G. N. S. (2024). Integrating contextual problem-based animated videos in mathematics learning. *Thinking Skills and Creativity Journal, 19*(1), 88–97. https://ejournal.undiksha.ac.id/index.php/TSCJ/article/view/92196

Doğanay, A., & Dolapcioglu, S. (2022). Development of critical thinking in mathematics via authentic learning. *International Journal of Mathematical Education in Science and Technology, 53*(3), 376–392. https://www.tandfonline.com/doi/abs/10.1080/0020739X.2020.1819573

Jablonka, E. (2020). Critical thinking in mathematics education. In Lerman, S. (Ed.), *Encyclopedia of Mathematics Education* (pp. 145–148). Springer. https://link.springer.com/content/pdf/10.1007/978-3-030-15789-0_35.pdf

Kamid, K., Sabil, H., & Syafmen, W. (2021). Problem-based learning and mathematics process skills in elementary school. *Jurnal Ilmiah Sekolah Dasar, 5*(2), 150–160. https://ejournal.undiksha.ac.id/index.php/JISD/article/view/37157

Kurniawati, K. R. A., & Negara, H. R. P. (2024). Implementation of problem-based learning to enhance critical thinking skills in mathematics. *Journal UMMAT, 6*(1), 72–81. https://journal.ummat.ac.id/index.php/issrectec/article/view/22362

Masriah, Utaminingsih, S., & Utomo, S. (2023). The influence of problem-based learning model on mathematics learning outcomes in elementary school students. *AIP Conference Proceedings, 2733*, 030021. https://pubs.aip.org/aip/acp/article-abstract/2733/1/030021/2900532

Narahmalia, I., & Subhanarrijal, A. (2024). PBL to increase activeness and result study mathematics material fractions. *ICoTPE Proceedings*, 6(1), 210–216. https://seminar.ustjogja.ac.id/index.php/ICoTPE/article/view/3005

Poluakan, C., Ratulangi, N., & Wantu, M. (2024). Implementation of the problem-based learning model in teaching of mathematics about adding fractions. *International*

Journal of Instructional Technology and Education, 7(1), 32–41. https://www.ijite.jredu.id/index.php/ijite/article/view/174

Ren, T. E. (2022). Development of critical thinking in mathematics through PBL in young learners. *RSU Institutional Repository*. https://rsuir-library.rsu.ac.th/handle/123456789/2153

Richardo, R., Usman, A., & Wati, R. (2025). Effectiveness of PBL to improve mathematical critical thinking skills: A literature study. In *Proceedings of the AAICE International Conference 2023* (pp. 112–118). Atlantis Press. https://www.atlantis-press.com/proceedings/aaice-23/126011443

Sachdeva, S., & Eggen, P. O. (2021). Learners' critical thinking about learning mathematics. *International Electronic Journal of Mathematics Education, 16*(2), em0659. https://www.iejme.com/article/learners-critical-thinking-about-learning-mathematics-11003

Torres-Peña, R. C., & González, D. P. (2024). Enhancing fraction learning through problem-solving and historical context. *ICME Conference Proceedings*, 1(1), 99–106. https://www.academia.edu/download/118628283/Layout_07_Edwan_Anderson_Ariza_Echeverri.pdf

Utami, R. W., & Suwanto, F. R. (2017). PBL to improve proportional reasoning in mathematics learning. *AIP Conference Proceedings, 1868*(1), 050002. https://pubs.aip.org/aip/acp/article-abstract/1868/1/050002/641745

Yohannes, D. J., & Tamur, M. (2021). The effect of problem-based learning model on mathematical critical thinking skills of junior high school students: A meta-analysis study. *Jurnal Penelitian Pendidikan Indonesia (JP3I), 8*(2), 155–164. https://pdfs.semanticscholar.org/5e47/fe57e300a3cb486c4571eb1aad274b782e3e.pdf